

Analysis of Leukemia Incidence (1996-2000) and Mortality (1994-2002) Data in St. Charles County, and Weldon Spring and Its Surrounding Areas



April 2005

***Missouri
Department of
Health and Senior
Services***

***Division of
Community Health***



Shumei Yun, MD, PhD
Chronic Disease Epidemiologist

Janette Candido
Epidemiologist Specialist

Analysis of Leukemia Incidence (1996-2000) and Mortality (1994-2002) Data in St. Charles County, and Weldon Spring and Surrounding Areas

Summary: In this study, the observed number of incident cases of leukemia in St. Charles County, Weldon Spring and its surrounding ZIP codes during 1996-2000 were compared with the expected number of cases based on the incidence rates for the State of Missouri during the same period; the observed number of leukemia deaths during 1994-2002 were also compared with the expected numbers of death based on the leukemia mortality rates for the State of Missouri during the same period. This study found that leukemia incidence rates during 1996-2000 and mortality rates during 1994-2002 in St. Charles County, Weldon Spring and its surrounding ZIP codes were not significantly different from that of the State of Missouri; the incidence rates for cancers that may be associated with exposure to radiation sources (such as sunlight, x-rays, gamma rays and other naturally occurring or man made sources of radiation) or result from a number of other genetic, lifestyle or unknown risk factors during 1996-2000 and mortality rates during 1994-2002 in St. Charles County were not significantly higher than that in the State of Missouri during the same periods.

Introduction:

Weldon Spring Site and Citizen's Concerns:

The Weldon Spring site is an area in St. Charles County, about 30 miles west of St. Louis, that was contaminated with hazardous radiological and chemical substances. The contamination stems from production of 2, 4, 6 – trinitrotoluene (TNT) and 2, 4 and 2,6 Dinitrotoluene (DNT) by the U.S. Department of Army from 1941 to 1945 and from enrichment of uranium ore and thorium processing by the Atomic Energy Commission from 1958 to 1966. In 1987, the Department of Energy began cleanup actions. Most of the soils have been removed and deposited into a 42-acre disposal cell located on-site in the vicinity of the former feed material plant.

U.S. Department of Energy environmental studies of the site indicate that potential exposure of humans to hazardous substances is below guidelines and that there is no contamination of drinking water. Nonetheless, the public is concerned about the hazardous effect of the sites on the population's health, especially childhood leukemia.

Missouri Department of Health and Senior Services (DHSS)'s Efforts of Monitoring Cancer/Leukemia Incidence and Mortality in St. Charles County

In response to the local citizens' concerns, the DHSS (former Missouri Department of Health [DOH]) has conducted several studies of the incidence and mortality of leukemia for the region. The findings of these studies are summarized as follows:

In 1983, DOH's Cancer Control Program reviewed cancer death in St. Charles County during the period of 1970-1982. The death data were analyzed for each ZIP code and each city or town in the county. No significant cancer mortality excesses were found by this study.

During the same year, DOH's Section of Disease Prevention examined childhood cancer incidence data during 1974-1982, which had been collected by a local citizen's group, and mortality data for the same time period. There was no significant excess of cancer incidence, but deaths from leukemia in children were significantly higher than expected.

In 1986, DOH studied hospital records for cases of childhood leukemia diagnosed during 1970-1983 in St. Charles County. When the number of observed cases in St. Charles County was compared with the number of expected cases during the time period, no significant excess was found. However, when the data were broken down into three time periods, 1970-1974, 1975-1979, and 1980-1983, a significant excess was detected in the 1975-1979 time period. The study also reviewed environmental monitoring reports for the Weldon Spring site. Based on these reviews, it was concluded that the excess childhood leukemia was not caused by radiation from Weldon Spring.

In 1994, DOH's Cancer Inquiry Program used the data from the Missouri Cancer Registry (MCR) to compare the observed new cases of leukemia during 1985-1992 to expected numbers of cases. The study found the number of leukemia cases was elevated for the 15-44 year age groups for females and for both sexes combined in St. Charles County. The study also found that the number of leukemia cases was elevated in the 15 years or younger age group for females and for both sexes combined in ZIP codes 63301, 63303, and 63304 during the same period.

During the same year, a study conducted by MDOH showed that the number of deaths due to leukemia during 1983-1993 among St. Charles County residents and the residents in ZIP codes 63301, 63303, and 63304 were not significantly different from the expected number of deaths based on leukemia death rates for the State of Missouri.

Objectives of the Current Study

The objectives of the current study were to continue the DHSS's efforts of monitoring leukemia incidence and mortality in St. Charles, Weldon Spring and its surrounding areas, and to compare the cancer incidence and mortality rates in St. Charles, Weldon Spring and its surrounding areas with that in the State of Missouri.

Study Methods

The Missouri Cancer Registry data were used for this analysis to compare the observed number of incident cases of leukemia during 1996-2000 with the expected number of cases for various gender and age groups based on the incidence rates in the State of Missouri during the same time period. The number of leukemia deaths during 1994-2002 was compared with the expected number of leukemia deaths for various gender and age groups based on the mortality rates for the State of Missouri during the same time period. When calculating the expected number of cases or deaths, the age-, gender-, and race-specific incidence or mortality rates of leukemia in the State of Missouri were applied to the study population of the corresponding demographic groups to obtain an expected number of cases for the study area (i.e., using the indirect method of standardization). Poisson analysis was used to evaluate whether the observed number of leukemia incident cases or deaths were statistically significant from that expected. A probability

of 0.01 or less for an observed number of cancer cases or deaths that was higher or lower than the expected number was considered to be a statistically significant difference.

The age-adjusted cancer incidence rates for cancers that may be associated with exposure to radiation sources (as noted in Table 5, page 6) during 1996-2000 and mortality rates during 1994-2002 in St. Charles County and that in the State of Missouri during the same period were compared. The 99% confidence intervals of the state rates and the county rates were compared. If there was no overlap in the 99% confidence intervals, the differences were considered statistically significant.

The 0.01 significance level was chosen in this study to correct for multiple comparisons while assuring an appropriate level of sensitivity in detecting differences.

Results:

The number of incident cases of leukemia during 1996-2000 in St. Charles County was not significantly different from that expected based on the leukemia incidence rates of the State of Missouri (Table 1). The number of incident cases of leukemia in Weldon Spring (ZIP code: 63304) and surrounding ZIP codes (63301, 63303, 63366, and 63376, individually or in combination) was not significantly different from that expected based on the incidence rates of the State of Missouri (Table 2).

The number of leukemia deaths during 1994-2002 in St. Charles County (Table 3), Weldon Spring and its surrounding ZIP codes was not significantly different from the expected number based on the leukemia mortality rate of the State of Missouri during the same period (Table 4).

The age-adjusted incidence rates for cancers that may be associated with exposure to radiation during 1996-2000 and mortality rates during 1994-2002 in St. Charles County were not significantly different for that in the State of Missouri during the same periods (Table 5-6).

Discussion:

Missouri Cancer Registry data for the period of 1996-2000 has more than a 95% completion rate. Therefore, the quality of data used in this study is higher than that used in the previous years. However, the possibility of a biased comparison in the leukemia incidence between St. Charles County and the State of Missouri cannot be completely ruled out. For example, hospitals in St. Charles County might have a higher cancer-reporting rate than other parts of the state due to a higher awareness. If this is true, it is expected that there is a greater likeliness of finding a significantly higher leukemia incidence in St. Charles County than that in the state when actually there is no difference. Since no statistically significant difference was found in this study, this appears not to be a major concern of this study.

Another limitation of this study is that, since there was no inter-census population data available at the ZIP code level, the 2000 census data was used to estimate the population for the State of Missouri, St. Charles County, and Weldon Spring and its surrounding Areas during 1994-2002. In doing so, an assumption was made that the population changes in St. Charles, and Weldon Spring and its surrounding areas during 1994-2002 are similar to that in the State of Missouri.

Before drawing conclusions from these data, two aspects of the statistical method need to be considered. First, random fluctuations in disease occurrence cannot be completely ruled out in explaining differences between the observed and expected numbers, even when the difference is statistically significant. The problem of random fluctuation is expected to be more prominent as the study areas become smaller. The second aspect is the power of the statistical test, that is, the probability that a true departure from the expected number can be detected by significance testing. A non-significant difference sometimes reflects the low statistical power rather than the absence of differences. In this study, the power of detecting a difference was higher for the five ZIP codes combined than for an individual ZIP code, and higher for both sexes combined than for female or male alone.

Conclusions:

The observed number of incident cases of leukemia during 1996-2000 in St. Charles County, and Weldon Spring and its surrounding ZIP codes was not significantly different from the expected number of cases based on the leukemia incidence rates of the State of Missouri. The observed number of leukemia deaths during 1994-2002 in St. Charles County, and Weldon Spring and its surrounding areas was not significantly different from the expected number of deaths based on the mortality rates of the State of Missouri during the same period. The age-adjusted incidence rates for cancers that may be associated with exposure to radiation during 1996-2000 and mortality rates during 1994-2002 in St. Charles County were not significantly higher than that in the State of Missouri during the same periods.

Recommendations:

Based on available data, an excess of leukemia in Weldon Spring, its surrounding ZIP codes, and St. Charles County was not found. No excesses in cancers commonly associated with radiation exposure were found in St. Charles County. However, the Cancer Inquiry Program should continue to monitor the cancer incidence and mortality rates in Weldon Spring and its surrounding areas. When additional year incidence and mortality data are available, another study should be conducted with the year 2000 as the midpoint to compensate for the limitation of lacking ZIP code level population in this study.

Table 1
Observed and Expected Numbers of Incident Cases of Leukemia by Age and Gender
Residents of St. Charles County, Missouri
1996-2000

Age	Female			Male			Total		
	Obs	Exp	Sig	Obs	Exp	Sig	Obs	Exp	Sig
0-14	6	5.3	No	9	8.7	No	15	14.0	No
15-44	9	8.3	No	7	10.0	No	16	18.3	No
45-64	9	16.2	No	21	20.5	No	30	36.7	No
65+	29	28.0	No	44	35.5	No	73	63.5	No
Total	53	57.8	No	81	74.7	No	134	132.5	No

Data Source: Missouri Cancer Registry

The expected numbers are based on the age-, sex-, and race-specific leukemia incidence rates in the State of Missouri.

Table 2
Observed and Expected Numbers of Incident Cases of Leukemia by Age and Gender
Residents of ZIP Codes 63301, 63303, 63304, 63366 and 63376, Missouri
1996-2000

Age	Female			Male			Total		
	Obs	Exp	Sig	Obs	Exp	Sig	Obs	Exp	Sig
0-14	6	4.71	No	9	7.82	No	15	12.53	No
15-44	6	7.48	No	7	8.98	No	13	16.46	No
45-64	9	14.05	No	18	17.70	No	27	31.76	No
65+	24	24.67	No	34	30.53	No	58	55.20	No
Total	45	50.91	No	68	65.03	No	113	115.95	No

Data Source: Missouri Cancer Registry

The expected numbers are based on the age-, sex-, and race-specific leukemia incidence rates in the State of Missouri.

Table 3
Observed and Expected Numbers of Leukemia Deaths by Age and Gender
Residents of St. Charles County, Missouri
1994-2002

Age	Female			Male			Total		
	Obs	Exp	Sig	Obs	Exp	Sig	Obs	Exp	Sig
0-14	2	2.3	No	5	2.5	No	7	4.8	No
15-44	10	7.2	No	9	8.7	No	19	15.8	No
45-64	14	15.6	No	21	19.3	No	35	34.9	No
65+	45	44.7	No	64	51.5	No	109	96.2	No
Total	71	69.8	No	99	82.0	No	170	151.7	No

Data Source: Missouri Death Records

The expected numbers are based on the age-, sex-, and race-specific leukemia mortality rates in the State of Missouri.

Table 4
Observed and Expected Numbers of Leukemia Deaths by Age and Gender
Residents of ZIP Codes 63301, 63303, 63304, 63366 and 63376, Missouri
1994-2002

Age	Female			Male			Total		
	Obs	Exp	Sig	Obs	Exp	Sig	Obs	Exp	Sig
0-14	2	2.02	No	5	2.27	No	7	4.3	No
15-44	9	6.45	No	9	7.8	No	18	14.24	No
45-64	14	13.53	No	18	16.69	No	32	30.22	No
65+	41	39.46	No	52	44.41	No	93	83.87	No
Total	66	61.46	No	84	71.17	No	150	132.63	No

Data Source: Missouri Death Records

The expected numbers are based on the age-, sex-, and race-specific leukemia mortality rates in the State of Missouri.

Table 5
Incidence Rates in St. Charles County and the State of Missouri for Cancers that may be
associated with Radiation Exposure
1996-2000

Sites [#]	St. Charles County			Missouri		
	N	Rate*	99% CI	N	Rate*	99% CI
Leukemia Total	140	13.8	10.9 – 17.2	3,421	11.9	11.5 - 12.3
Multiple Myeloma	57	5.6	3.8 – 7.8	1,415	4.9	4.6 - 5.2
Lymphoma Total	236	21.9	18.3 – 25.9	6,052	21.2	20.7 - 21.8
Hodgkin's disease	40	3.2	2.0 – 4.8	768	2.8	2.7 - 3.0
Non-Hodgkin's lymphoma	196	18.7	15.3 – 22.5	5,284	18.5	18.0 - 19.0
Thyroid	74	5.6	4.0 – 7.5	1,758	6.4	6.1 - 6.7
Brain	80	6.7	4.9 – 8.9	1,962	7	6.7 - 7.3
Breast	783	69.2	62.8 – 74.1	19,882	70.4	69.4 - 71.4
Skin Total	153	13.5	10.8 – 16.6	3,154	11.2	10.8 - 11.6
Melanomas – skin	134	11.5	9.1 – 14.4	2,768	9.8	9.5 - 10.2
Lung and bronchus	786	76.4	69.4 – 81.8	23,280	80.7	79.7 - 81.8

Data Source: Missouri Cancer Registry.

* Rates per 100,000, and age adjusted using 2000 US standard population.

^ If there is no overlap in 99% confidence interval, the difference was judged as statistically significant.

[#] Only invasive cancers were included in the analysis.

Table 6
Radiation-related Cancer Mortality Rates in St. Charles County and the State of Missouri
1994-2002

Sites	St. Charles County			N	Missouri	
	N	Rate*	99% CI		Rate*	99% CI
Leukemia Total	170	9.6	7.8 – 11.6	4,184	8	7.7 – 8.3
Multiple Myeloma and immunoproliferative	74	4.3	3.1 – 5.7	2,031	3.9	3.7 – 4.1
Hodgkin's disease	12	@. @	@. @ – @. @	260	0.5	0.4 – 0.6
Non-Hodgkin's lymphoma	140	8.2	6.5 – 10.1	4,573	8.7	8.4 – 9.1
Brain, meninges and other parts of the nervous system	117	5.8	4.5 – 7.3	2,657	5.2	4.9 – 5.5
Breast	311	16.7	14.3 – 19.3	8,243	16	15.5 – 16.4
Melanoma	59	2.9	2.0 – 4.0	1,496	2.9	2.7 – 3.1
Trachea/Bronchus/Lung	1,104	61.5	56.8 – 66.5	33,573	64.3	63.4 – 65.2

Data Source: DHSS-Missouri Information for Community Assessment (MICA).

* Rates per 100,000 and age adjusted using 2000 US standard population.

@. @ indicates numerator too small for rate calculation.

^ If there is no overlap in 99% confidence interval, the difference was judged as statistically significant.